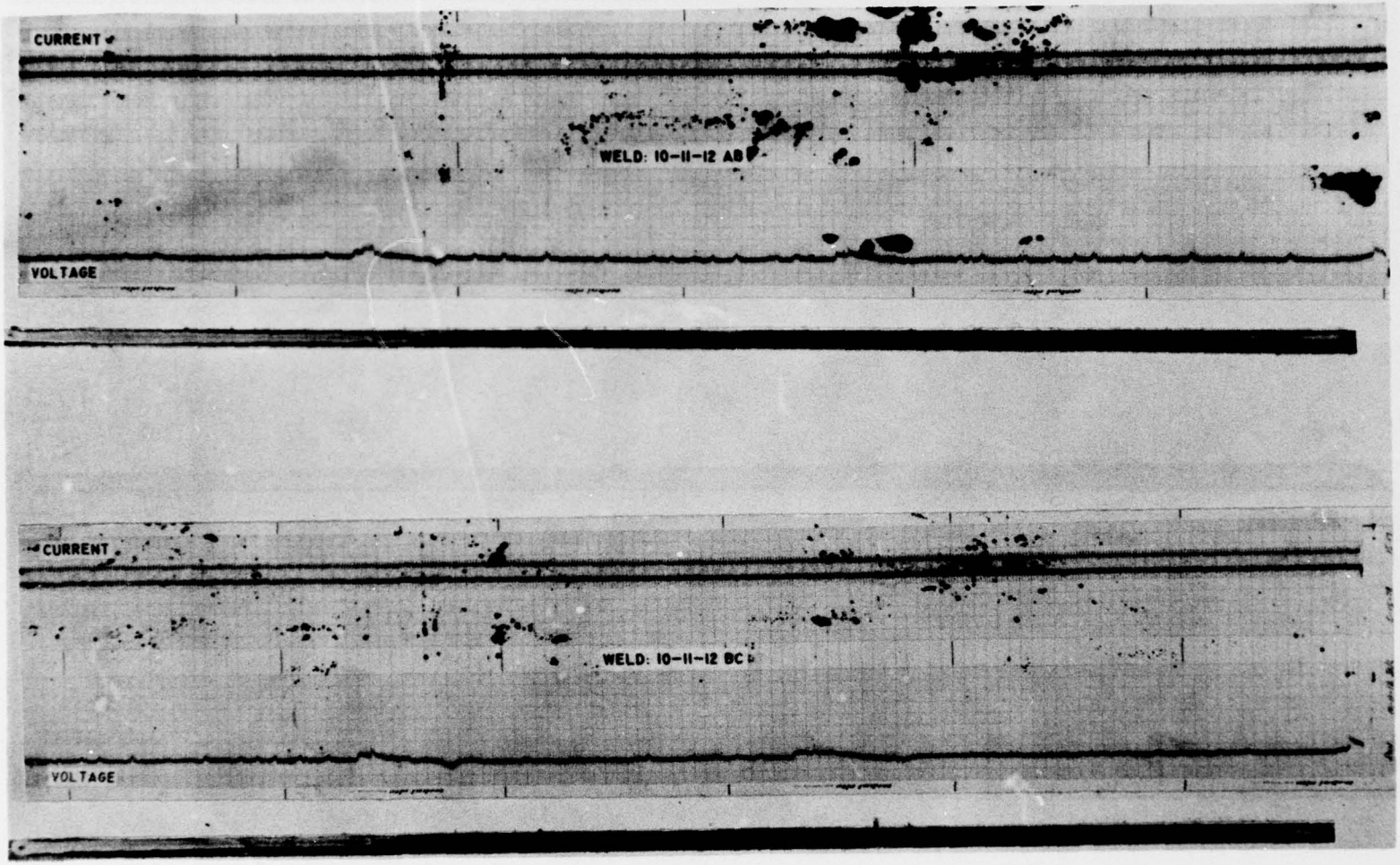
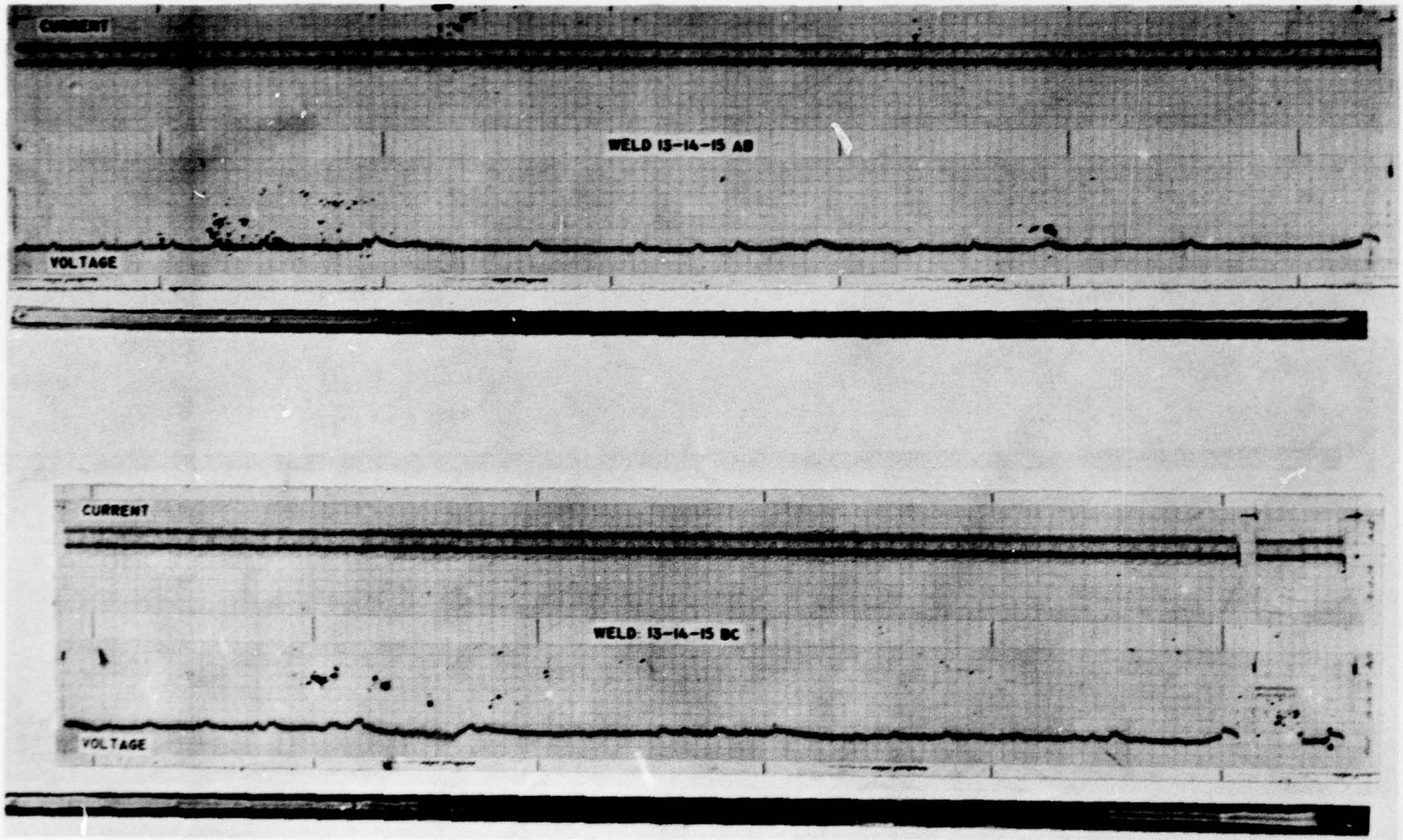
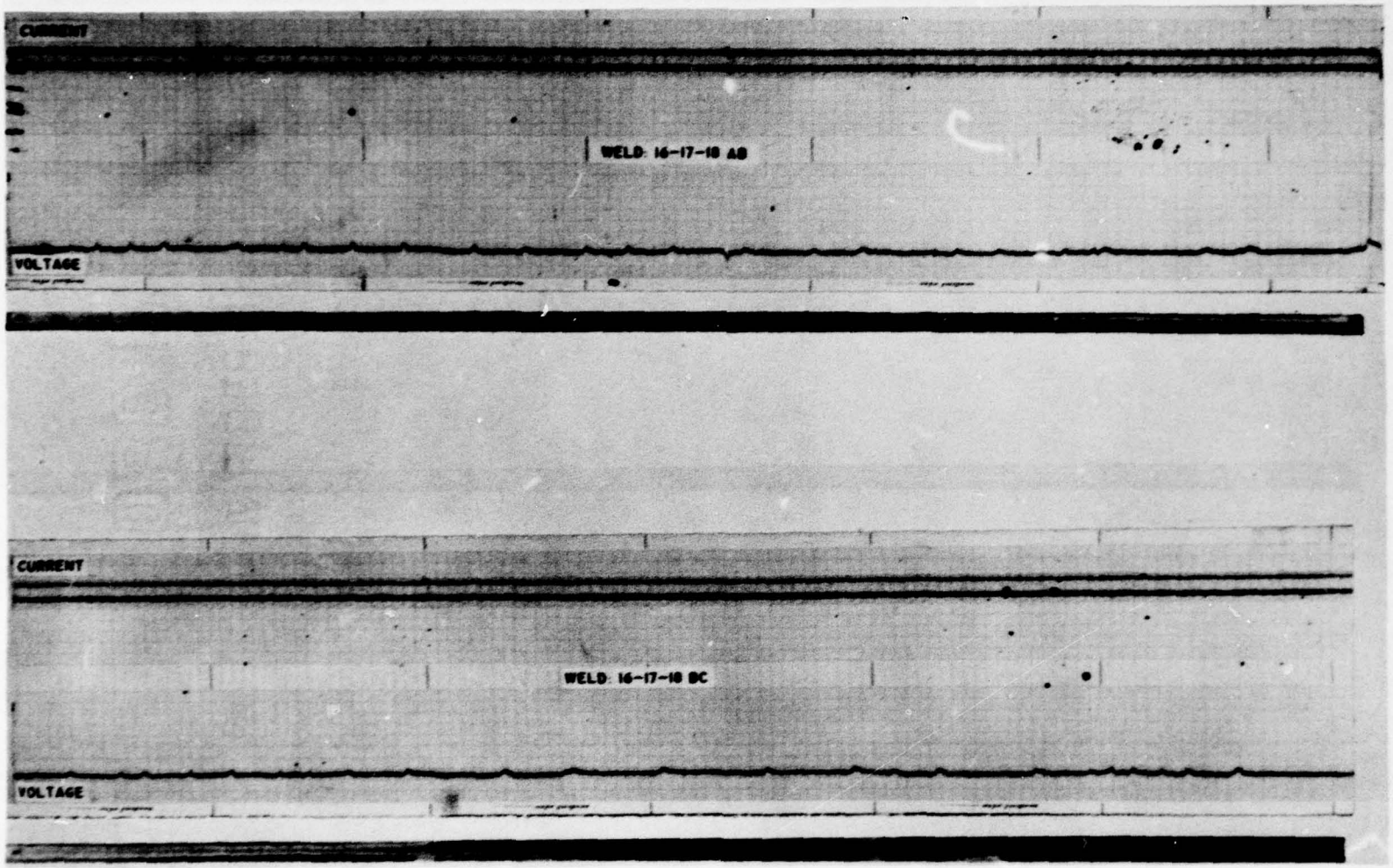
AD-A061 045 BABCOCK AND WILCOX CO LYNCHBURG VA LYNCHBURG RESEARC--ETC F/G 17/1
ACOUSTIC EMISSION MONITORING OF TIG WELDING.(U)
JUL 78 R S WILLIAMS, C F ZUR LIPPE DAAG46-77-C-0055
UNCLASSIFIED AMMRC-TR-78-34 NL

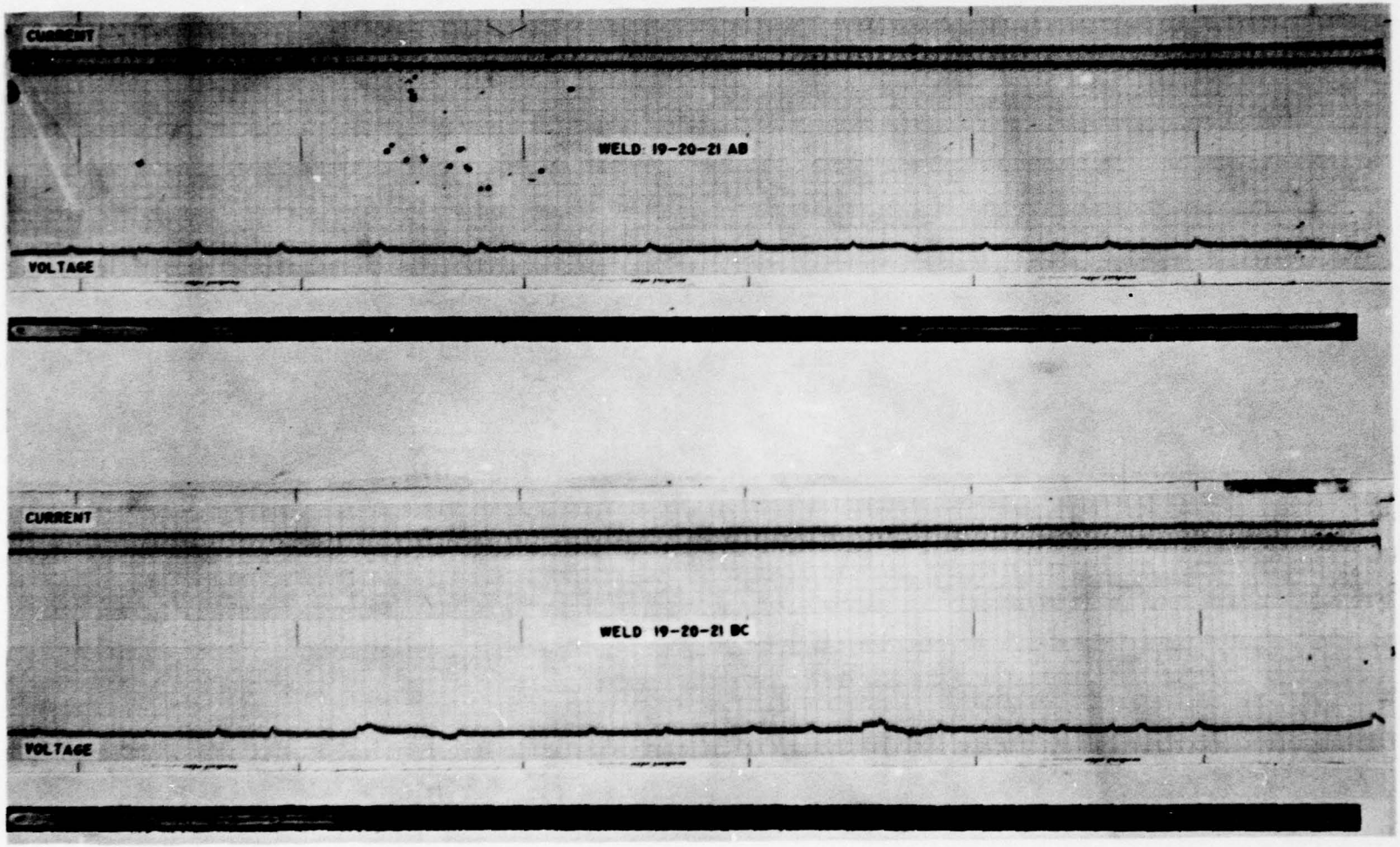
2 OF 2
AD A061 045

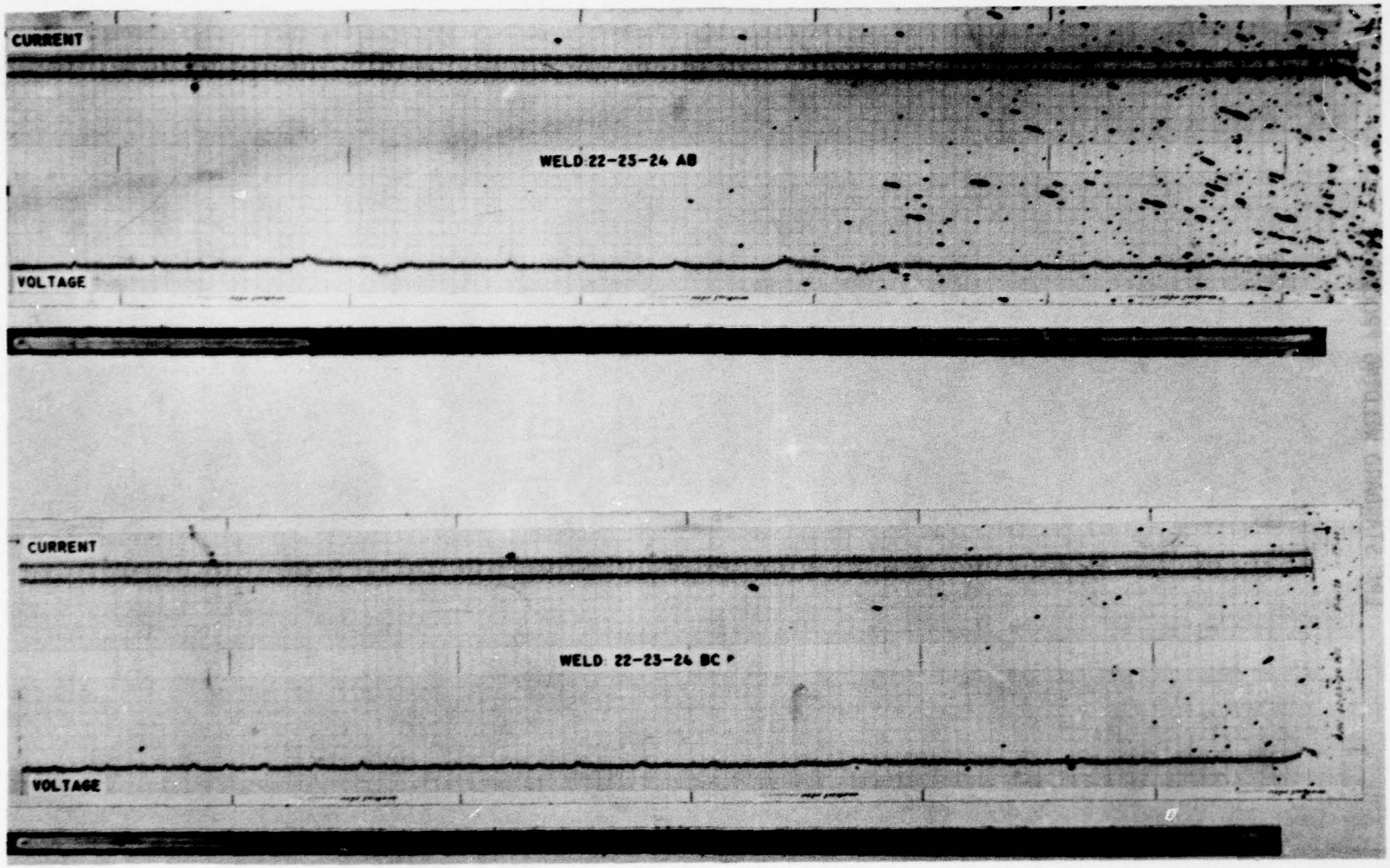
END
DATE FILMED
2-79
DDC


CURRENT
WELD: 10-11-12 AB
VOLTAGE
CURRENT
WELD: 10-11-12 BC
VOLTAGE


CURRENT
WELD 13-14-15 AB
VOLTAGE
CURRENT
WELD 13-14-15 BC
VOLTAGE


CURRENT
WELD: 16-17-18 AB
VOLTAGE
CURRENT
WELD: 16-17-18 BC
VOLTAGE


CURRENT
WELD 19-20-21 AB
VOLTAGE
CURRENT
WELD 19-20-21 BC
VOLTAGE


CURRENT
WELD 22-23-24 AB
VOLTAGE
CURRENT
WELD 22-23-24 BC
VOLTAGE

APPENDIX A-3

LRC STANDARD WELDING PROCEDURE

BABCOCK AND WILCOX
RESEARCH AND DEVELOPMENT DIVISION

TECHNICAL PROCEDURE

NUMBER LRC-TP-72

TITLE ASSEMBLY OF PARTS BY INERT ARC FUSION WELDING

ISSUE NUMBER 07

ASSIGNED TO C. F. zur Lippe

PREPARED BY Clarence F. zur Lippe 5/23/78

APPROVED BY J B Thorp, PE 5/25/78

APPROVED BY D. F. Ferrell 5/30/78

RESEARCH AND DEVELOPMENT DIVISION

TECHNICAL PROCEDURE

DATE 5/23/78

REVISIONS		
DATE	DESCRIPTION	APPROVED
5/23/78	Original issue	

DISTRIBUTION

R. J. Beauregard
R. H. Coppo
C. W. Dalton
L. J. Ferrell
L. B. Gross
W. R. Sutherland
C. F. zur Lippe
Library

1. Scope

This Technical Procedure establishes rules and requirements for machine-welding by the inert arc fusion welding process to assure the production of high-quality weldments.

2.0 Operator Qualification

2.1 The operator shall demonstrate his ability to set up and operate designated weld equipment by producing 3 test weldments of simulated joint design.

2.2 The operator qualification tests will be conducted by an examiner designated by the Manager, Nuclear Materials Technology Section.

2.3 Operator qualification shall be limited to the material groups and machine welding processes for which they have been specifically tested.

2.4 Whenever low or unacceptable quality weldments are produced by the operator, immediate corrective action shall be taken as follows: Machine settings shall first be checked for accuracy and repeatability If the machine is not at fault, the operator's qualification shall be revoked. Only after additional training, may the operator be retested.

2.5 Operator qualification shall only be valid for six months beyond the date of testing.

3.0 Fabrication Welding Procedure

3.1 A weld schedule shall be established for each welding operation. All set-up parameters for a specific operation shall be shown on a weld schedule operations sheet (Table 3-1.). Instrument settings may be varied within the allowable ranges specified in Table 3-2.

3.2 Subassembly parts and fixture tooling shall be thoroughly cleaned by ultrasonic cleaning in CP acetone or in accordance with a designated cleaning specification prior to assembly and welding of components. Thereafter, operators shall wear clean, white, lint-free gloves when handling components.

3.3 Parts shall be assembled and positioned for welding using the fixtures and tools specified by the applicable operations sheet.

3.4 Joint fit-up conditions shall either meet or exceed engineering drawing requirements but may not exceed the maximum permissible joint mismatch conditions specified in Figure 3.1.

3.5 When tack-welds are required to position details or attach weld start and end tabs to the part, weld heat input shall be "balanced" to minimize shrinkage distortion. After tack-welding, metal vapor deposits shall be removed by stainless steel wire brushing.

3.6 Trailing shields shall be used in all instances when weld discoloration is not acceptable.

3.7 An inert gas weld chamber shall be used when it is necessary to shield the weld from atmospheric contamination. Residual oxygen concentration of the protective atmosphere shall be monitored continuously and shall not exceed 15 PPM at any time either prior to or during the welding operation. Acceptable weld deposits must have a bright silvery color. Dew point of backfill gas shall be maintained below -65F.

GTAW-Fusion Welding Schedule Sheet

Assembly Name:	**Serial No.:**
Assembly Drawing No.:	**Weld Process:**
Base Metal Mat'l:	**Joint Configuration:**
Heat Treat Cond.:	**Weld Position:**
Mat'l Thickness:	**Weld Penetration:**
Date Welded:	**Power Supply:**

Welding Sequence (No. of passes)	1	2	3
Joint Description			
Weld Polarity, SP-RP-AC			
Preheat Current, Amps			
Preheat Dwell Time, sec.			
Upslope Control Time, sec.			
Low Pulse Current, Amps			
High Pulse or Steady State Current, Amps			
"ON"-Time, %			
Pulse Rate, PPS			
Voltage, V @ Peak Current			
Downslope Control Time, sec.			
Postheat Current, Amps			
Postheat Dwell Time, sec.			
Weld Travel Speed, IPM			
Speed Control Setting, %			
Weld Travel Delay, sec.			
Filler Wire Mat'l (Spec.)			
Wire Diameter, in.			
Wire Feed Speed, IPM			
Feed Start Delay, sec.			
Wire Feed Time, sec.			
Joint Preheat Temperature, F			
Interpass Temperature, F			
Weld Post Heat Temperature, F			
Torch Make and Model No.		Cleaning & Tacking Instructions:	
Shield Cup/Nozzle Size			
Torch Rake Angle, deg.			
Standoff Dist.: Shield Cup-Workpiece, in.			
Electrode Mat'l Type and Size			
Tip Geometry (pointed-blunt)			
Standoff Dist.: Electrode-Workpiece, in.			
Shielding Gas or Mixture			
Gas Flow Rates, CFH:			
a) Torch Shield Cup			
b) Torch Orifice (Plasma Arc only!)			
c) Overhead Trailing Shield			
d) Underhead Trailing Shield			
Underbead Gas Back Pressure, in.H_2O			
Preflow/Postflow Times, sec.			
Inert Atmosphere Chamber Make & Size			
Positive Pressure, in. H_2O			
Purge Gas Flow Rate, CFH			
Weld Fixture Tooling:			
a) Type			
b) Tool Number			
Weld Energy Input, KJ/in.			

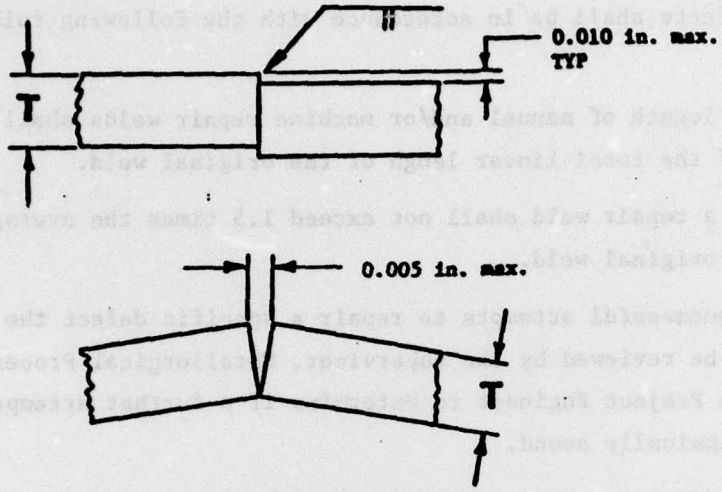
Table 3-1

Setpoint Allowables for Non-Consumable and Consumable Type Electrode Inert Arc Welding Processes

	GTAW & PAW	GMAW
Amperage	±10%	±15%
Voltage	± 2 V	±10%
Gas Flow Torch	± 3 CFH	± 5 CFH
Shield Gas Flow Over- and Underbead	± 5 CFH	± 5 CFH
Welding Speed	± 4%	± 3%
Wire Feed Speed	±10%	± 5%

Table 3-2

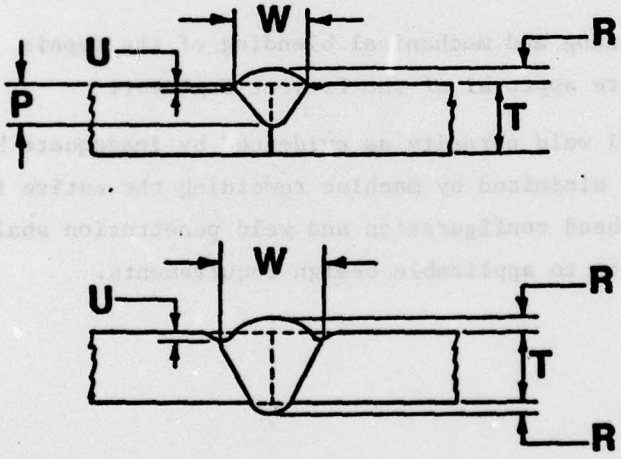
(1) Pre-Weld Misalignment Limits



(a) Parallel Offset

(b) Angular Offset

(2) Weld Bead Geometry



(a) Partial Penetration ($P \leq T$)

(b) Full Penetration ($P = T$)

W, Overbead Width: 2 T max.
R, Weld Reinforcement: 0.1 T max.
U, Undercut: 0.15 T max.
P, Penetration: Per applicable specification or drawing

Figure 3.1. Maximum Permissible Joint Mismatch During Weld Constraint (Square butt weld, no filler wire addition)

4.0 Weld Repair

Repair of weld defects shall be in accordance with the following rules and requirements:

4.1 The combined length of manual and/or machine repair welds shall not exceed 10% of the total linear lengh of the original weld.

4.2 The width of a repair weld shall not exceed 1.5 times the average width of the original weld.

4.3 After two unsuccessful attempts to repair a specific defect the matter shall be reviewed by the Supervisor, Metallurgical Process Group and the Project Engineer to determine if a further attempt at repair is technically sound.

4.4 Filler wire additions, when required, shall match the base metal composition. Wire shall be wiped clean with lint-free cloths and approved solvent.

4.5 Cosmetic finish-machining and mechanical blending of the repair weld zone shall require approval of the Project Engineer.

4.6 Conditions of internal weld porosity as evidenced by inadequate helium leak tightness may be minimized by machine rewelding the entire first pass weld. However, bead configuration and weld penetration shall conform in all respects to applicable design requirements.

5.0 Quality Control

5.1 Reactive metal and refractory metal weldments with blue or darker discoloration shall be rejected. The welding process shall be stopped until the source of contamination is found and eliminated.

5.2 Test weldments of simulated joint design shall be metallographically prepared to reveal the outline of the fusion zone.

5.3 Weld assembly of parts shall not proceed until repeatability of weld schedule parameters has been confirmed to enable consistent production of desired weld penetration and bead configuration.

5.4 Nondestructive examination and leak-tightness inspection, when required, shall be performed in accordance with applicable specifications.

6.0 Documentation

A copy of all records pertaining to operator qualifications, test and fabrication weld schedules, and quality control shall be maintained in an appropriate project file by the Project Engineer.

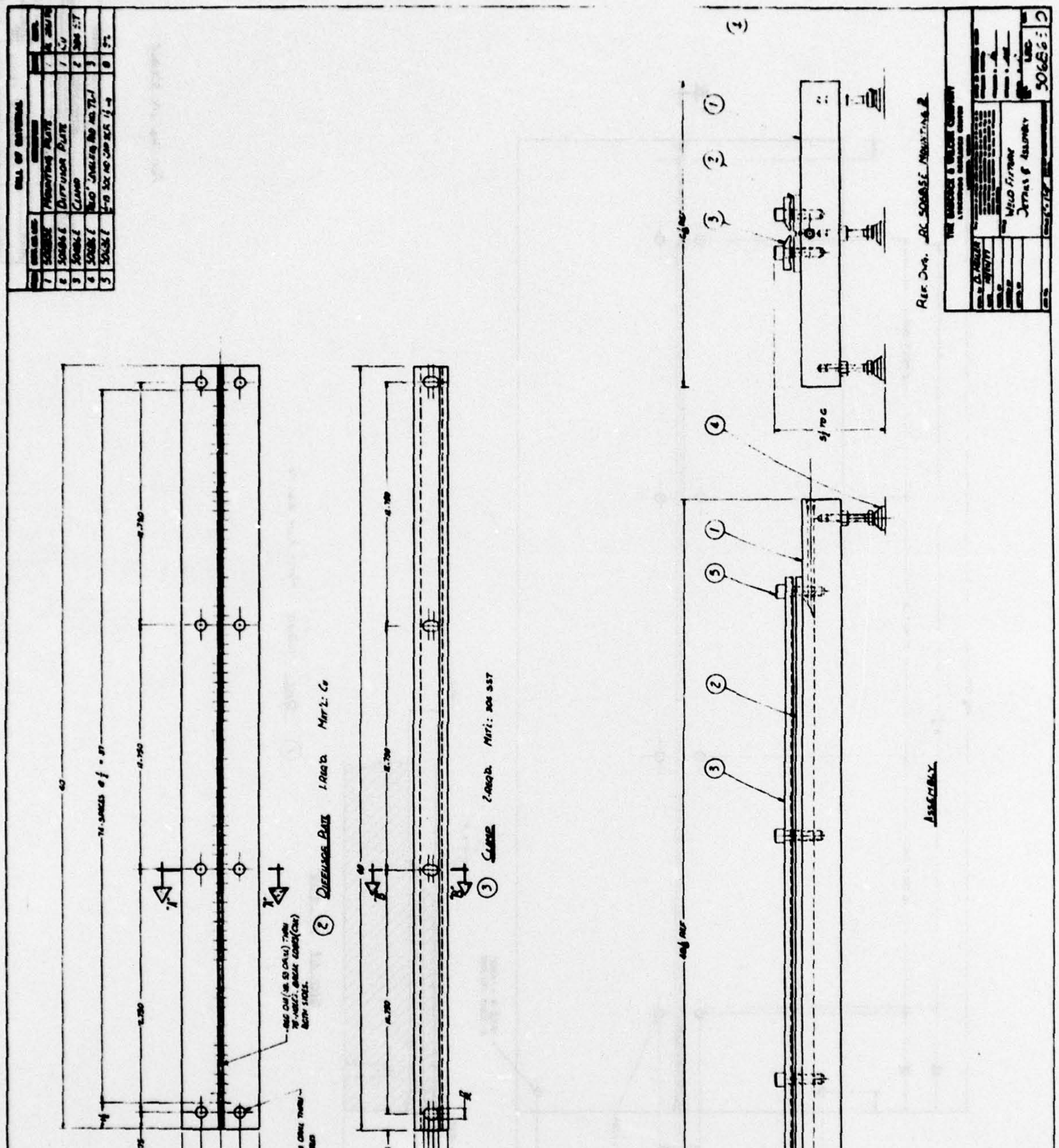
7.0 Application

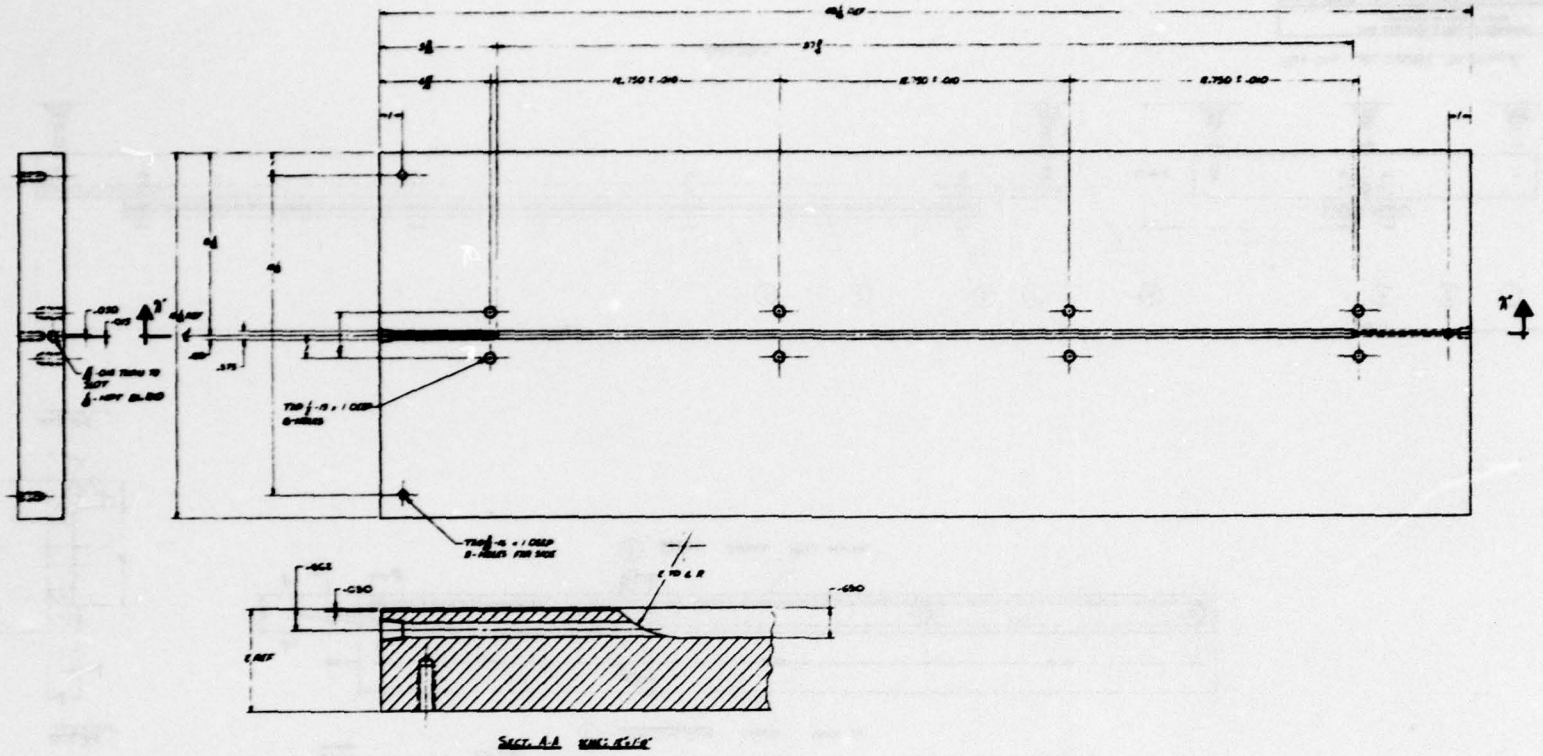
Application of this Technical Procedure shall include the foregoing rules and requirements and the following specific instructions:

7.1 Reactor Vessel Material Surveillance Program, End Fittings: Table 7-1.

APPENDIX A-4

FIXTURE DRAWINGS





SECT. A-A

① BASE 1-REQ'D MAT'L: ALUM 6061 T-6

REF. DWG. LDC 50685

THE BABCOCK & WILCOX COMPANY

WELD FIXTURE MOUNTING 'R' DETAIL

LDC 50685 0

DISTRIBUTION LIST

No. of Copies	To
1	Office of the Director, Defense Research and Engineering, the Pentagon, Washington, D.C. 20301
12	Commander, Defense Documentation Center, Cameron Station, Alexandria, Virginia 22314
1	Advanced Research Projects Agency, The Pentagon, Washington, D.C. 20315
	Metals and Ceramics Information Center, Battelle Columbus Laboratories 505 King Avenue, Columbus, Ohio 43201
2	ATTN: Mr. Daniel Maykuth
	Chief of Research and Development, Department of the Army, Washington, D.C. 20310
2	ATTN: Physical and Engineering Sciences Division
1	Dr. Bernard R. Stein
	Commander, U.S. Army Material Development and Readiness Command, 5001 Eisenhower Avenue, Alexandria, Virginia 22333
1	ATTN: DRCDE-DE, Development Division
1	DRCDE-RS, Research Division
1	DRCDE-RS, Scientific Deputy
1	DRCLDC, Mr. R. Zentner
	Commander, U.S. Army Aviation Research and Development Command, P.O. Box 209, Main Office, St. Louis, Missouri 63166
1	ATTN: DRSAV-LEP, Mr. J. M. Thorp
	DRSAV-ER, Dr. I. Peterson
	Commander, U.S. Army Missile Research and Development Command, Redstone Arsenal, Alabama 35809
1	ATTN: DRSMI-IE, Mr. J. E. Kirshtein
1	DRSMI-R, Mr. John L. McDaniel
1	DRSMI-RBLD, Redstone Scientific Information Center
1	Chief Scientist, Dr. W. W. Carter
1	Directorate of R&D
1	Dr. B. Steverding
	Commander, U.S. Army Mobility Equipment Research and Development Command, 4300 Goodfellow Boulevard, St. Louis, Missouri 63120
1	ATTN: DRSME-PLC, Mr. J. Murphy
1	Commander, U.S. Army Tank-Automotive Research & Development Command, Warren, Michigan 48090
1	ATTN: DRDTA-PPS, Mr. David Siegel
1	Mr. B.A. Schevo

No. of Copies	To
	Commander, U.S. Army Armament Material Readiness Command, Rock Island, Illinois 61201
2	ATTN: DRSAR-QA
1	DRSAR-QAE
	Commander, U.S. Army Armament Research and Development Command, Dover, New Jersey 07801
1	ATTN: DRDAR-SCM, Dr. K. Iyer
1	DRDAR-LC, Mr. E. Kelly
1	DRDAR-LCA, Dr. Sharkoff
1	DRDAR-LCE, Dr. Walker
2	DRDAR-QAS, Mr. F. Fitzsimmons
1	DRDAR-SCM, Mr. J. Corrie
1	DRDAR-TSP, Mr. B. Stephans
2	DRDAR-TSS, (STINFO)
	Commander, Aberdeen Proving Ground, Maryland 21005
3	ATTN: Technical Library, Building 313
	Commander, U.S. Army Foreign Science and Technology Center, 220 7th Street, N.E., Charlottesville, Virginia 22901
1	ATTN: DRXST-SD3
	Commander, Rock Island Arsenal, Rock Island, Illinois 61201
1	ATTN: SARRI-RDL
	Director, Eustis Directorate, U.S. Army Air Mobility Research & Development Laboratory, Fort Eustis, Virginia 23604
1	ATTN: SAVDL-EU-S5, Mr. J. Robinson
	Commander, U.S. Army Ballistic Research Laboraoties, Aberdeen Proving Ground, Maryland 21005
1	ATTN: Dr. D. Eichelberger
	Director, U.S. Army Material Systems Analysis Activity, Aberdeen Proving Ground, Maryland 21005
1	ATTN: AMXSY-D, Dr. J. Sperrazza
	Commander, U.S. Army Mobility Equipment Research & Development Center, Fort Belvoir, Virginia 22060
2	ATTN: Technical Documents Center, Building 315
	Commander, U.S. Army Production Equipment Agency, Manufacturing Technology Branch, Rock Island Arsenal, Illinois 61202
1	ATTN: AMXPE, Mr. Ralph Siegel
	Commander, U.S. Army Research and Engineering Directorate, Warren, Michigan 48090
1	ATTN: SMOTA-RCM.1, Mr. Edward Moritz
1	SMOTA-RCM.1, Mr. Donald Phelps

No. of Copies	To
	Commander, Watervliet Arsenal, Watervliet, New York 12189
1	ATTN: SARWV-R
1	Dr. Robert Weigle
1	Chief, Bureau of Naval Weapons, Department of the Navy, Room 2225, Munitions Building, Washington, D.C.
	Chief, Bureau of Ships, Department of the Navy, Washington, D.C. 20315
1	ATTN: Code 341
	Chief of Naval Research, Arlington, Virginia 22217
1	ATTN: Code 472
	Headquarters, U.S. Ari Force/RDPI, The Pentagon, Washington, D.C. 20330
1	ATTN: Major Donald Sponberg
	Headquarters, Aeronautical Systems Division, 4950 TEST W/TZHM (DH 2-5 Mgr), Wright-Patterson Air Force Base, Ohio 45433
1	ATTN: AFML-MATB, Mr. George Glenn
2	AFML-MXE, E. Morrissey
1	AFML-LLP, D.M. Forney, Jr.
1	AFML-LC
1	AFML-MBC, S. Schulman
	National Aeronautics and Space Administration, Washington, D.C. 20546
1	ATTN: AFSS-AD, Office of Scientific & Technical Information
1	Mr. B.G. Achhammer
1	Mr. G.C. Deutsch, Chief, Materials Research Program, Code RR-1
	National Aeronautics and Space Administration, Lewis Research Center, 21000 Brookpark Road, Cleveland, Ohio 44135
1	ATTN: Mr. G. Mervin Ault, Assistant Chief, M&S Division
	National Aeronautics and Space Administration, Marshall Space Flight Center, Huntsville, Alabama 35812
1	ATTN: S&E-ME-MM, Mr. W. A. Wilson, Building 4720
1	R-P&VE-M, R. J. Schwinghamer
	Albany Metallurgy Research Center, Albany, Oregon 97521
1	ATTN: Mr. R.R. Wells, Research Director
	Defnese Materials Service, General Services Administration, Washington, D.C. 20405
1	ATTN: Mr. Clarence A. Fredell, Director, Technical R&D Staff
	Director, Army Materials and Mechanics Research Center Watertown, Massachusetts 02172
2	ATTN: DRXMR-PL
1	DRXMR-X
1	DRXMR-M
1	DRXMR-MQ
1	DRXMR-MR
1	DRXMR-L
2	DRXMR-LP
1	DRXMR-CT
1	DRXMR-PR
1	DRXMR-MI
	Author

Army Materials and Mechanics Research Center
Watertown, Massachusetts 02172
FINAL REPORT ON ACOUSTIC EMISSION
MONITORING OF TIG WELDING
R.S. Williams and C.F. zur Lippe,
Babcock & Wilcox, Lynchburg Research
Center, Mt. Athos Road, Lynchburg,
Virginia 24505
Technical Report AMMRC TR 78-34, July 1978, 101 pp.
illus - tables, Contract DAAG46-77-C-0055
Final Report, July 22, 1977 to July 22, 1978

AD_____

UNCLASSIFIED
UNLIMITED DISTRIBUTION

Key Words

Acoustic emission
TIG welding
D6AC steel
Real time monitor
Porosity
Cracks

The purpose of this program is to apply AE technology to TIG welding of D6AC panels typical of those proposed for improved roll and weld fabrication of rocket motor cases. Test panels were welded to simulate lontitudinal, circumferential, and intersection welds. After welding, conventional nondestructive and destructive examinations of these welds were performed. Based upon analysis of these results, AE weld monitoring was shown capable of reliably detecting typical weld-induced defects.

Army Materials and Mechanics Research Center
Watertown, Massachusetts 02172
FINAL REPORT ON ACOUSTIC EMISSION
MONITORING OF TIG WELDING
R.S. Williams and C.F. zur Lippe,
Babcock & Wilcox, Lynchburg Research
Center, Mt. Athos Road, Lynchburg,
Virginia 24505
Technical Report AMMRC TR 78-34, July 1978, 101 pp.
illus - tables, Contract DAAG46-77-C-0055
Final Report, July 22, 1977 to July 22, 1978

AD_____

UNCLASSIFIED
UNLIMITED DISTRIBUTION

Key Words

Acoustic emission
TIG welding
D6AC steel
Real time monitor
Porosity
Cracks

The purpose of this program is to apply AE technology to TIG welding of D6AC panels typical of those proposed for improved roll and weld fabrication of rocket motor cases. Test panels were welded to simulate lontitudinal, circumferential, and intersection welds. After welding, conventional nondestructive and destructive examinations of these welds were performed. Based upon analysis of these results, AE weld monitoring was shown capable of reliably detecting typical weld-induced defects.

Army Materials and Mechanics Research Center
Watertown, Massachusetts 02172
FINAL REPORT ON ACOUSTIC EMISSION
MONITORING OF TIG WELDING
R.S. Williams and C.F. zur Lippe,
Babcock & Wilcox, Lynchburg Research
Center, Mt. Athos Road, Lynchburg,
Virginia 24505
Technical Report AMMRC TR 78-34, July 1978, 101 pp.
illus - tables, Contract DAAG46-77-C-0055
Final Report, July 22, 1977 to July 22, 1978

AD_____

UNCLASSIFIED
UNLIMITED DISTRIBUTION

Key Words

Acoustic emission
TIG welding
D6AC steel
Real time monitor
Porosity
Cracks

The purpose of this program is to apply AE technology to TIG welding of D6AC panels typical of those proposed for improved roll and weld fabrication of rocket motor cases. Test panels were welded to simulate lontitudinal, circumferential, and intersection welds. After welding, conventional nondestructive and destructive examinations of these welds were performed. Based upon analysis of these results, AE weld monitoring was shown capable of reliably detecting typical weld-induced defects.

Army Materials and Mechanics Research Center
Watertown, Massachusetts 02172
FINAL REPORT ON ACOUSTIC EMISSION
MONITORING OF TIG WELDING
R.S. Williams and C.F. zur Lippe,
Babcock & Wilcox, Lynchburg Research
Center, Mt. Athos Road, Lynchburg,
Virginia 24505
Technical Report AMMRC TR 78-34, July 1978, 101 pp.
illus - tables, Contract DAAG46-77-C-0055
Final Report, July 22, 1977 to July 22, 1978

AD_____

UNCLASSIFIED
UNLIMITED DISTRIBUTION

Key Words

Acoustic emission
TIG welding
D6AC steel
Real time monitor
Porosity
Cracks

The purpose of this program is to apply AE technology to TIG welding of D6AC panels typical of those proposed for improved roll and weld fabrication of rocket motor cases. Test panels were welded to simulate lontitudinal, circumferential, and intersection welds. After welding, conventional nondestructive and destructive examinations of these welds were performed. Based upon analysis of these results, AE weld monitoring was shown capable of reliably detecting typical weld-induced defects.